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CRYSTAL OF TOURMALINE.

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THE TOURMALINE.

ITS RELATION AS A GEM; ITS COMPLEX NATURE; ITS WONDERFUL PHYSICAL PROPERTIES, ETC., ETC.; WITH SPECIAL REFERENCE TO THE BEAUTIFUL AND MATCHLESS CRYSTALS FOUND IN THE STATE OF MAINE.

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"It is a strange analogy, well worthy of fixing the attention of philosophers. . . . These jewels, which have the privilege of attracting our gaze, and of fixing our eyes upon them by an unaccountable species of magnetism, appear also to incite the secret affinities of lightning."—Abbé Fonvielle.

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INTRODUCTION.

THE study of the gems and the precious stones furnishes many instructive and interesting themes to the student of science, the philosopher, or the historian. To either, these inanimate objects, which the learned Abbé Haüy elegantly called "the flowers of the mineral kingdom," afford a vast and almost limitless field of inquiry and research. The student, startled or entranced by the marvellous revelations of their physical properties, is led by his inquiries into the very depths of Nature's mysteries; and the historian, as he recalls the pages of the world's history, and seeks to fathom the strange fascinations which the gems have in all times exercised over the minds of men, listens with a

well-defined feeling of credulity to the strange tales of Oriental fable. The visions of the Genii, the gigantic phantoms of the Afrites, are not so far distant and inexplicable, after all, when we come to consider the causes which give birth to the fabulous, or create in the bosom of the earth the transparent crystals of precious stone. The same telluric magnetism, or electricity, which elevates to the very heavens those lofty columns and weird-like forms of dust, or gives rise to the startling mirage of the horizon and the strange flashings and coruscations of light that appear in the darkness of night, also silently deposits in the earth, or even in the interior of the solid rocks, those wonderful crystals of symmetrical form and dazzling colors which are the very emblems of purity and perfection on earth. The philosopher, viewing the subject in an impartial light, will admit that this passion for the glittering and mysterious gems is not merely a love of finery, or an acquired taste dependent upon the freaks of fashion, but that it springs from a deeper source, and is inherent in human nature. It is exemplified in the rich grandee when

lavishing millions for gem decorations, as well as in the child when gathering flowers on the meadow in spring to adorn its person. It is simply obedience to one of the laws that perfect our nature, — the love of the beautiful. We also find that the precious stones have, from time immemorial, exercised a powerful influence over all the human families, though widely scattered over the globe, not only in civilized and refined life, but among the wild Arabs of the desert, and the ruder savages of remote islands and secluded countries. How many beautiful examples of their effects come to us through the mists of antiquity, tinged, perhaps, with the rosy tints of the fabulous, but illustrating the force and sway of the beautiful in nature upon the disposition of man! How brilliant and potent must have been the gleams of that wonderful opal which induced the Roman senator Nonias to depart into exile rather than yield up his matchless gem to the greedy Marc Antony who coveted it! for exile then to a Roman was worse than death. Of what transcendent beauty must have been the iridized tints of that idolized pearl which

the mediæval Greeks lost to Alp Arslan, and which the Byzantine historians long lamented even more bitterly than all the Asiatic provinces won from them by the Turk! The traditions of thousands of years have given to many of the gems a glorious prestige, and have almost justified a belief in their marvellous properties. Most of these traditions and legends relating to the precious stones have come from Arabia and Persia, —those countries which are but stretches of rock and sand, yet whose every feature predisposes man to thought; where the visible is viewed only through the mirage of the imagination; and where the limpidity of the firmament, the serenity of the stars, and the transparency of the night, insensibly lead men to contemplation.

In these countries the superstitious mind is ever prone to seize upon the strange in nature, and transform the appearance or the action to the presence or power of some mighty and unseen force. Those who have travelled over the Arabian deserts, or across the almost limitless expanse of sands of Africa, can readily comprehend the origin of some of the creations that

people Oriental fable and history. Those tall sand-pillars which mysteriously arise from the desert, and fairly pierce the vault of heaven with their awful forms, — moving majestically over the earth with a silent yet terrible power, — may readily suggest to human fancy the ideas of the gigantic Afrites; and, in like manner, many of the Arabian creations may be ascribed to an exalted and perverted view of natural phenomena. It is also not only interesting, but highly instructive, to trace out the origin of the mystic power of gems portrayed all through the charming tales of Eastern romance. We may then understand how this belief of magic and talismans, arising from the credulous simplicity of the shepherds of the plains and the deserts, afterwards passed to Greece and Rome, and gave birth to those exquisite forms of beauty and sentiment of the Greek and Roman art which have descended to us in the shape of engraved gems. There is yet a deeper and nobler interest in this subject, which commerce has debased in pandering to the frivolities of mankind; and it is impossible to study with untrammelled mind the nature of these beautiful

and wondrous crystalline bodies, which no man has yet been able to fully comprehend and explain, without becoming aware of a definite intent on the part of the Creator.

THE TOURMALINE.

CHAPTER I.

HISTORY OF THE TOURMALINE. — ITS DISCOVERY, AND THE DERIVATION OF ITS NAME.

THE tourmaline, even at the present day, is but little known, except to the amateur or the mineralogist; yet it is, perhaps, the most interesting of all the gems, when we come to consider the beauty and diversity of its color, the complexity of its composition, and the wonders of its physical properties. Although it has been exposed in the gem marts of Europe for a long time, yet its identity and true description are hardly a century old. The gem must have been known to the ancients, although there is no direct allusion to it by the gem-writers of the early periods. However, it

is more than probable that some of the red tourmalines of the Uralian and Altian range of mountains in Siberia were gathered with those beautiful sky-blue beryls which were so highly prized at Rome, and which were then brought from the distant wilds of Scythia; and when the victory of Pompey over Mithridates fully made known to the Romans the fascinating beauty of Oriental gems, and awakened a taste for pearls, porcelain, and precious stones, the tourmaline must have been found among the varieties of gems that were brought from the gem mines of Ceylon and India.

The regular commerce established by the Arabs between these countries for a long period undoubtedly introduced into the bazaars of the Mediterranean some of these stones. But their characteristics were overlooked; or they may have been confounded with other minerals, the precise nature of which was then but imperfectly understood. The earliest description among ancient writers the antiquary can discover as applicable to the stone in question is in the writings of the Greek philosopher Theophrastus, who mentions a stone found in

the Island of Cyprus, and which exhibited the unusual appearance of being emerald-green at one end, while it was of jasper-red at the other. This description may be readily applied to the tourmaline; for its crystals are sometimes red at one extremity, and green at the other: and, moreover, this peculiarity in the distribution of color belongs to no other gem. Crystals of sapphire are sometimes red and blue at their extremities, or yellow and blue; but a specimen displaying red and green hues in the same crystal is unknown.

Similar crystals of tourmaline have been found on another island of the Mediterranean Sea; and there is now, in a cabinet of minerals in this country, a tourmaline of light red and green which was found in the iron mines of Elba. Pliny, three centuries later, speaks in a vague manner of violet and brown stones, which acquired the curious property of attracting light bodies when heated in the rays of the sun, or even when warmed by friction with the fingers. In this characteristic description the mineralogist will at once recognize the tourmaline, and not the sapphire, nor the brown and violet

topaz; for they were then unknown. Had the Latin philosopher intended to describe a peculiarity of the sapphire, he would undoubtedly have mentioned the red, the blue, and the yellow varieties also; for they all exhibit the same electrical properties alike, but not in so marked a degree as the tourmaline. Tourmalines of these particular colors are found at the present day in the mines of Ceylon and Pegu, and in the same districts which have yielded precious stones to commerce for more than two thousand years.

Beyond these obscure remarks, history does not devote a line nor a word to this remarkable stone; and for seventeen hundred years it is completely overlooked or forgotten.

In the middle of the seventeenth century, Brazil sent to the European market, among her exports, long prisms of dark-green stone; but De Laet, who wrote on gems at that time, and who ought to have recognized the crystals by their well-marked characteristics, simply termed them Brazilian emeralds, and also incorrectly asserted that they were harder than the true emerald of Peru.

At length the discovery came, and in the simple way that many of the truths of Nature have been revealed. On a warm summer's day early in the eighteenth century, some children were at play in a court-yard at Amsterdam. Their playthings lay exposed to the rays of the sun on the hot pavement; and among them were some of the precious stones the Dutch navigators had brought home from the gem-producing countries in the East Indies, and especially from Ceylon, which was then in possession of Holland. The children were astonished to behold some of the stones suddenly possessed with a strange power; for they attracted or repelled with a decided force ashes, straws, and other substances of little weight. The parents were summoned to view the strange scene.

The stolid Dutch lapidaries were, however, sorely perplexed at the mysterious action of the stones, which seemed endowed with the principle of life or motion; but, totally unable to determine the nature of the stone, or explain its singular properties, they gravely, and perhaps wisely, termed them *aschentreckers*, or "ash-drawers."

This curious story having been circulated abroad, it came to the hearing of M. Lemery, a gentleman of scientific tastes; and, after procuring a specimen of the stone, he exhibited its powers of attraction and repulsion to the French Academy of Sciences in 1727. But here all investigation and scientific inquiry ceased for nearly forty years. At this time a German physician, by name Æpinus, became interested in the report concerning the strange properties of the stone; and, obtaining two from Mr. Lechman, he commenced a series of experiments connected with the effect of heat and friction. After making a careful investigation of the subject, he published the results of his inquiries and experiments in the History of the Academy of Sciences at Berlin in 1756. The scientific world was startled at last with the statements of his memoir; and experimentalists over all Europe made haste to obtain specimens of the wonderful stone. The Duke de Noya, an Italian nobleman, obtaining two from Holland, hastily made some experiments in a careless way, and submitted his report to the French Academy. The duke, led astray by the

imperfections of his observations, objected to some of the statements of Æpinus, and openly pronounced them incorrect. At this juncture of affairs, Dufay, Haller, Adamson, Colomb, and other *savans*, came to the rescue of Æpinus, and proved by their careful and varied experiments that he was correct. In England the spirit of inquiry was also aroused: and Dr. Heberden, obtaining the only tourmaline which was then in Great Britain, called to his aid some of the English philosophers; and they also confirmed the received opinion of its wonderful electric power. Fashionable society also became interested in the excited discussions of the philosophers; and the disputed stones were eagerly sought for by the fop as well as by the philosopher or the *dilettante*.

One of Hogarth's pictures, painted at this period, represents a gay youth arrested while absorbed with the wonders of the tourmaline when held up to the rays of the sun. Mr. Wilson and Mr. Carlton, two of the most eminent electricians of their day, also procured a number of tourmalines from Holland, and submitted them to numerous and interesting ex-

periments, which fully sustained the assertions of Æpinus. Dr. Franklin became interested in the subject, and, after experimenting upon one of the stones, wrote to Dr. Heberden in 1759, supporting his theories. During the hot discussion which prevailed, the stones were described under various names, and were by some geologists supposed to be identical with the "lyncurium" of the ancients, which is now known to be the yellow zircon.

As all the accessible specimens had been cut by the Dutch lapidaries, or were in rounded masses like water-worn pebbles, the form of crystallization, and the common characteristics of tourmalines and schorl, were not then recognized. Linnæus, in 1768, was the first to intimate their relationship; but it was reserved for Romè De Lisle to describe the Ceylon crystals, and establish their identity with the black variety, which had been known in Europe for almost two centuries. It was, however, a long time before the disputants adopted the present name of *tourmaline*, which is derived from the ancient Cingalese word *turmali*, and not *turamali*, which we understand is applied by

the natives of Ceylon to the zircon. This remarkable mineral belongs evidently to rocks of crystallization, and never appears in the secondary terrains, or rocks of transition, with the exception of the gem mines of Ceylon, and perhaps Burmah. It is found generally in granite, mica schist, talc or talcose schist; and is divided by the chemist Rammelsberg into five sub-groups; viz., the magnesia, the iron magnesia, the iron, the iron manganese, and lithia and the lithia tourmalines. It is to the fourth and fifth group that our memoir is especially directed.

Tourmalines of these two groups often occur in beautifully-crystallized three-sided prisms, terminated by three principal planes, which sometimes are set on one extremity of one of the sides of the prism, and, on the other, on the edges. Its primitive form of crystallization is the obtuse rhomboid, having the axis parallel to the axis of the prism. The edges of these prisms are often truncated; and then the crystals form prisms of nine or twelve sides. However, it sometimes occurs massive and compact, or in parallel, divergent, radiating, and detached

crystals. Its fracture is decidedly conchoidal, exhibiting internally a vitreous lustre. Its specific gravity ranges from 3 to 3.3; and its refractive power is 1.66, being superior to the topaz in brilliancy. Its hardness is 7.5, and quite equal to that of the emerald.

The tourmaline has as great a variety of names and synonymes as the sapphire; and in both minerals they arise from the great diversity of colors displayed by them. The red variety is known among mineralogists as the rubellite, siberite, or daourite; the blue as the indicolite; the white as achroite; and the black as aphrizite, or schorl. But, at the present day, they are all grouped under one name.

CHAPTER II.

LOCALITIES AND PECULIARITIES OF DEPOSITION AND DISTRIBUTION.

THE principal localities for the transparent and finest specimens of the tourmaline are in Siberia, Brazil, Ceylon, and the State of Maine of the United States. In Siberia they are found in masses of felspar and quartz in coarse granite. There are several localities in this great country, — some near Ekaterinsburg and Sarapulsk, and others at Nertschink in Eastern Siberia, and near the confines of Northern China. The tourmalines found at these places exhibit a great variety of color: among them occur stones of the true ruby tint (the pigeon's-blood hue), and various shades of purple and of green. The arrangement of color observed in some of the crystals is quite remarkable, and differs from that seen

in the specimens from other parts of the world. Some of these stones exhibit internally a blue or brown color, surrounded on the outside with a bright carmine-red, or of a dull yellow, waxy hue. Others may be red internally, enveloped with a pistachio green. Sometimes the crystals are of huge dimensions, and built up of solid material or of a multitude of acicular crystals; or they may occur in long, needle-like forms.

A great variety of color is displayed in these crystals. They may be pink at the summit, and light green at the base; or crimson, tipped with black iron ore. They may also be of a resinous yellow, coated with carmine of intense hue; or of a dark green, changing into an indigo-bluish tinge. The finest red-tinted tourmalines yet known have come from some of these localities. Some of these stones resemble the red sapphire known as the Oriental ruby so perfectly in color, that it is impossible to distinguish them by the eye alone. They are extremely rare, and are as eagerly sought for by the *dilettante* at the same enormous price of the true ruby. We shall not be surprised if the magnificent ruby in the Rus-

sian crown of the Empress Anne Ivanovna proves to be a tourmaline; and it will not fall in our estimation of its value if it is a siberite. It came from Pekin, which is not far distant from the tourmaline mines of Nertschink. Of the same nature may be the monster red gem which hangs as a pendant to the jade necklace which belonged to the Chinese emperor, and which was captured by the French in the sack of Pekin. This variety of the tourmaline is very apt to be flawed, or filled with imperfections, and especially with hollow threads and feathers and fibres, which are rarely seen in the green, the yellow, or the blue varieties. It is certainly curious that this variety should be so much more liable to imperfections than any of the others, not excepting even the purple.

Purple, blue, and green varieties come from Brazil; but, concerning the formation in which they occur, we can learn but little. We judge, from the famous dispute in the seventeenth century among the Jesuits about a mine at Esperitu, that it is mined in Brazil as well as in Siberia. The crystals brought to us from that country generally do not show signs of having

been rolled in the drift; for the striæ of their sides are perfect. The absence and loss of perfectly faceted summits do not prove external violence, but rather a submission to the action of the elements, as observed in other localities. They occur of various shades of green, from the light tint to the darkest bottle-green. Sometimes we find them of a beautiful Berlin blue, or of a crimson passing insensibly into a bluish white or a bluish green. The most beautiful specimen yet produced by this country was not long since in the cabinet of minerals of the Duke of Florence.

It exhibited five splendid crystals of dark-green color on a matrix almost a foot square. Three of these superb crystals were erect, and one prostrate: they were fine prisms, and measured from two to four inches in length by three-quarters of an inch to an inch in diameter.

In Ceylon — the land of gems — the tourmaline, with the exception of the black variety, has not yet been discovered in place: they are always found there in the same gravel-beds of secondary formation with the sapphire, among

the *débris* of the rocks of crystallization. Often they occur in rolled masses or in natural nodules, and sometimes in crystals whose faces are uninjured, and whose angles are unbroken. The question may arise, How can this mineral occur in nodules, when the laws relating to its deposition and crystallization are apparently so rigid? We will not attempt to solve the mystery, but can produce many examples to prove that the tourmaline may deposit a nodular concretion in the midst of a perfect crystal. We have removed many tourmalines from the cavities at the locality in Maine which exhibit this peculiarity: the crystals were of perfect form, but shattered by the elements; and, as we attempted to remove them from their beds in the sand, the sharp angles and striated sides fell into minute fragments, leaving a bright rounded nodule in the midst of the stone. Sometimes this nodule would be near the summit or the base, and sometimes in the central portion.

If Nature can deposit the tourmaline in this form in the midst of well-defined crystallization, we can see no objection to the same deposition without the more perfect combinations. We

may also observe this tendency of Nature to globular concretion in several other minerals. It is well marked in the sapphires found in Ceylon in the same deposits with the tourmalines.

We may also find it illustrated in the diamond, and particularly in the white topaz and the chrysoberyl. The lapidaries notice that these nodules are more difficult to cut than are the well-defined crystals of the same mineral; and they also observe that they exhibit greater brilliancy. It has been well demonstrated that a perfectly formed and limpid crystal will not cut so brilliant a gem as one of these singular formations. In a future article upon the sapphire we will describe at length the peculiarities of the occurrence of the stone in the secondary formations of Ceylon, and attempt to explain some of the circumstances attending the manner of their deposition. The gem mines of Ceylon have yielded these stones for several thousand years, and probably supplied India and Persia for a long period of time. The range of color of the tourmalines found there is not very extensive: we have seen them of an

impure green, and of various shades of yellow and brown; we have also evidence of red, gray, and hyacinth varieties having been obtained from the same locality.

Ava, that unknown land of rubies, also occasionally sends forth into the commercial world some beautiful specimens of this gem; but every thing that relates to the mines — their locality, or the quantity of gems exhumed — is shrouded in darkness and mystery. The Burmese government refuse all access to the foreign explorer, and restricts the export of all her mineral treasures; but when the British embassy, under Col. Symes, visited the Burmese empire in 1795, the mogul presented them, among other gifts, a magnificent group of pink tourmalines. It is composed of several crystals beautifully striated and terminated, arising from a matrix of what appears to be amethystine quartz.

The specimen has been valued at one thousand pounds sterling, and is now placed in the British Museum. In this priceless depository of art and the natural treasures of the earth the display of tourmalines is grand, and of the

value of many thousand dollars. Every locality known on the globe is represented; and every variety of the stone, with its associate minerals, is exhibited. Among the rare specimens are some monster pink and crimson crystals from Ava, one of the kingdoms of the Burmese empire: these are composed of a multitude of long acicular crystals, sometimes rigidly straight and sometimes curved, and reminding one of miniature columns of basalt. This same peculiar arrangement of crystalline grouping is also witnessed in several of the tourmalines from Elba and Siberia, but not with so marked distinctness, nor on so grand a scale. At Roschnia in Moravia, it occurs in rose-colored and violet varieties in quartz and lepidolite in gneiss. Uto in Sweden yields fine crystals of deep red, purple, and blue, in a matrix of granite. The group of mountains of which St. Gothard is composed afford clear light-green specimens in dolomite, and which resemble in color the beautiful green beryls from the Ural Mountains. At Ariolo, at the foot of the St. Gothard pass on the Italian side, the rare white variety is found, but not in much perfection.

The Island of Elba produces crystals of tourmaline of various colors, associated with the famous iron ore, and deposited in steatite. Some of these crystals exhibit the tendency to acicular grouping which is so well marked in the specimens from Siberia and Ava. The colors of these tourmalines are not often of deep and decided hues, but pale in their tints. The rare white variety, known as the "achroite," is found here in greater abundance than in any other known locality: they are, however, generally translucent, or too defective to be cut into gems. We have seen specimens from this island which exhibit transparent white color at one extremity, and a light grass-green with a yellow tinge at the other; or of a light yellowish green throughout, tipped at both ends with iron ore. Pink is the most frequent color met with at this locality: although we have known them of a light green, changing at one extremity into quite an olive-black; or of a light rose-pink at one end, and pea-green at the other.

The mountains of the Tyrol are famous for their brown tourmalines, which excel all those of other known localities. The best deposit

was discovered by Mr. Wilkes. This traveller found them in a vein of talc and steatite situated in granite, on the lofty mountain known as Mt. Grenier, at the extremity of the valley of Zillethal. These tourmalines, which are called "tourmalines of Carenthia," are of a light yellowish brown, and sometimes of darker shades. They often occur in fine crystals, with both terminations faceted alike; which is an exception to the law of crystallography. Brown tourmalines of similar hue are also found in highly modified crystals at Gouverneur, N.Y., in a bed of granular limestone.

There are many localities in America where this variety occurs in more or less perfection; but the finest specimens come from Canada. Grand Calumet Island yields superb crystals of greenish yellow an inch thick; and Burgess produces specimens of a rich golden brown, reminding the amateur of that transcendent gem, the orange-tinted jargoon of Ceylon.

In the United States, there are but few localities where the colored tourmalines occur; and the best are found in the States of Massachusetts and Maine. In the town of Chesterfield, in the

State of Massachusetts, is a noted locality of green, red, and blue tourmalines. They are contained in granite which is crossed obliquely by a vein of smoky quartz and a silicious felspar known as "Cleavelandite." This vein is of a width varying from six to eighteen inches, and contains the tourmaline crystals. These tourmalines are embedded in the quartz and felspar, sometimes passing through both. They are in long rounded prisms, deeply striated longitudinally; and often exhibit well-defined, trihedral summits. They have been observed four inches long, and more than an inch in diameter; but the solitary red tourmalines are rarely ever over one-fourth of an inch in diameter. Some of the crystals are dark green; others pink, red, violet, or dark blue, and sometimes of a light blue. They are nearly always quite opaque; sometimes translucent, but never sufficiently transparent to serve as gems.

The arrangement of the crystals sometimes presents a singular appearance. Well-defined crystals of rubellite may be seen completely enclosed in a crystal of dark-green tourmaline. In one instance, three red crystals were aggre-

gated together, and enclosed by one of green. The green crystals sometimes embrace indicolite, and are often bent and dislocated by some unknown force. The energy of the dislocation, in several instances, has separated portions of a crystal, and subjected them to a kind of *échelon* movement, indicating that the disturbance took place before the crystallization was complete. Some of the crystals which contain the red tourmalines within the green are very remarkable; for they seem to be quite distinct, although the sides and angles of both prisms correspond. Sometimes, however, the separation is well marked by a thin layer of talc intervening between the two prisms. In some parts of the vein of smoky quartz, nearly every green tourmaline was observed to contain a rubellite. At the town of Goshen, six miles distant from the Chesterfield locality, the same formation occurs, but with a change in the colors of the tourmalines.

Here the red is rare; while the green, light azure, and dark blue are more abundant. The blue sometimes passes insensibly into green, becoming quite transparent. We have seen one

crystal of red, tinged with blue, that might be considered a gem. A few crystals have been observed of a brown hue, changing to nearly white; and others have been seen of a yellowish green. They occur not only in well-defined prisms, but are often seen of acicular forms, and in radiated groups. Both of these deposits are now said to be exhausted, having been quite superficial in their extent.

CHAPTER III.

DESCRIPTION OF MT. MICA AND ITS MINERAL TREASURES.

THE most remarkable locality of the tourmaline in the United States, and which is also one of the most celebrated in the world, is in the town of Paris, in the State of Maine. It occurs on the brow of a little hill, which has been named by the mineralogists Mt. Mica, from the abundance of the muscovite which occurs there. The hill is one of the spurs of a more considerable elevation called Streaked Mountain, from the rugged and denuded appearance of its sides. It is but few rods square in extent, and is covered with turf and alluvial earth, with the exception of a little space in the centre and at the summit, where the ledge bursts out to the view. Although it appears coarse and utterly valueless to the casual

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CRYSTAL OF TOURMALINE.

Exact Size.

glance, it is, nevertheless, one of the most remarkable mineral deposits on the face of the globe; for it has yielded from an area thirty feet square nearly forty varieties of minerals, some of them of extreme beauty and rarity.

It was discovered in the year 1820 by two students by the name of Elijah L. Hamlin and Ezekiel Holmes. They had been searching for minerals during the day along the mountain-ridge to the southward, and were then descending the western declivity on their way to the village. It was on the last day of autumn; and the glimmering rays of the setting sun were gilding with renewed splendor the faded colors of the landscape as the students were passing over the top of one of the lowest knolls. The view of the distant mountains (which are the loftiest in New England), the intervening valleys softened with purple shadows, the patches of green grass in the meadows untouched by early frost, the variegated hues of the forest-leaves left by the autumnal winds, the broad extents of russet brown of the stubble-fields, contrasting vividly with the glorious hues of the sunset sky, composed a scene of exquisite

loveliness. The youths, spell-bound by the entrancing beauty of the landscape, lingered upon the hill-top until the valleys were shrouded with the shadows of commencing twilight. As they turned to descend the hillock, a vivid gleam of green flashed from an object on the roots of a tree upturned by the wind, and caught the eye of young Hamlin. Advancing to the spot, he perceived a fragment of a transparent green crystal lying loose upon some earth which still clung to the root of the fallen tree. The student clutched the gem with eagerness; and calling back his companion, who had passed over the brow of the hill, they closely searched the surrounding soil for other specimens. But the rapidly-increasing twilight soon compelled the youthful mineralogists to abandon the search. They, however, resolved to return at daybreak, and continue the exploration. But during the night a storm arose, and covered the hill and its adjacent fields with a thick mantle of snow, which remained until spring.

As soon as the winter snows had melted away, and left the hill and its sides exposed, the stu-

dents returned to the search. They went directly to the ledge, which crops out on the summit of the hill, and which they had not examined before darkness overtook them on their previous visit. As they climbed up over the smooth and denuded surface of the rock, they were astonished to observe many crystals, and fragments of crystals, lying exposed upon the bare ledge, and sparkling in the rays of the sun. These they carefully gathered; and tracing others to the earth below the ledge, and which had formed from the decomposition of the rock, they eagerly turned up the soil in search of its hidden treasures. Thirty or more crystals of remarkable transparency and beauty rewarded the labors of the students; and with joy they held them up to the sunlight, and admired their varied colors of green, red, white, and yellow, of different shades.

They had, indeed, stumbled upon one of the richest and rarest of Nature's laboratories. All around the brow of the ledge, enormous masses of rose-red lepidolite, splendid groups of crystallized quartz of white and smoky hues, crystals of tin, broad foliæ of glistening mica, snowy

flakes of felspar, studded with transparent green and red tourmalines, lay scattered about in profusion. Collecting as many of the choice and beautiful specimens as they could carry, the students, heavily laden, returned to the village, and sought to ascertain the nature of their mineral treasures. Subsequent examination indicated that the ledge was perforated with cavities, in which the tourmalines and other rare minerals had been deposited. It was also evident that the crystals that had been gathered up by the students had been set free from their cavities by the decomposition of indefinite periods of time, which had removed the surface of the ledge. There was no evidence of drift; and the crystals lay exposed upon the rock; while the softer materials had been washed by the rain down to the base of the ledge, and accumulated as soil. Parts of the ledge yet exposed to view were fairly honeycombed with small cavities and soft spots, where the decomposing felspar was crumbling away. In these cavities and decayed places in the rock other tourmalines were obtained by breaking away the edges of the ledge, or removing the decomposed stone.

The discovery having been made known to the villagers, many of them hastened to the spot, and secured a number of fine specimens as trophies or mementoes. As no one in the vicinity was able to distinguish the character of the gems, or even make known their name, the students enclosed a few of the smaller crystals in a letter to Prof. Silliman, and requested him to describe them. He kindly and promptly informed the youths that the minerals were tourmalines, and of rare occurrence. Thereupon the students selected some of the finest and purest of the crystals, and addressed them to the professor in return for his kindness. The parcel was intrusted for safe keeping to the late Gov. Lincoln, who was then a member of Congress, and about to start for Washington. At this period the journey to the capital was a serious undertaking; and the condition of the roads required that it should be made on horseback, at least for a great part of the distance. The governor started safely with the precious package, but lost it before reaching New Haven; and no trace of it has ever been found.

Two years after the discovery, the younger brothers of the discoverer, Cyrus and Hannibal Hamlin, although scarcely in their teens, resolved to make an attempt at a more complete exploration of the ledge. Having borrowed some blasting-tools in the village, they proceeded to the hill, and managed, in a rough way, to drill four or five holes in the surface of the ledge, and blast them out. These operations, though of trivial magnitude, were attended with unlooked-for success; for the explosions threw out, to the astonishment of the boys, large quantities of bright-colored lepidolite, broad foliæ of transparent mica, and masses of quartz crystals of a variety of hues. The last blast exposed a decayed spot in the ledge, which yielded readily to the thrusts of a sharpened stick or the point of the iron drills. As the surface was removed, great numbers of minute tourmalines were discovered in the decomposed felspar and lepidolite. The rock became softer and softer as the boys proceeded in their labor of excavation; and soon they reached a large cavity of two or more bushels' capacity. This cavity, which was situated in

the heart of the solid ledge, was filled with a substance which appeared to be sand, loosely packed. Amongst this sand, or disintegrated rock, crystals of tourmaline of extraordinary beauty were found scattered here and there in the soft matrix. Scratching away with renewed energy, the boys soon emptied the pocket of its contents, and found that they had obtained more than twenty splendid crystals of various forms and hues. One of these was a magnificent tourmaline of a rich green color and remarkable transparency. It was more than two inches and a half in length by nearly two inches in diameter; and both of its terminations were finely formed, and were perfect. Several others possessed extraordinary beauty; and some of them were fully three inches in length, and an inch in diameter. The colors of these tourmalines were quite varied, but were chiefly red and green, and far surpassed in the purity and transparency of their hues the crystals collected by Elijah Hamlin in his previous examination of the locality. The exact number of crystals obtained is not now known; but when collected together, with the fragments of others,

they filled a basket of nearly two quarts' capacity. Besides the tourmalines, the quantity of lepidolite, mica, and other choice minerals, thrown out by the blasts, or found in the sides of the cavity, was so great, that the boys were obliged to seek for an ox-team to transport them home. So little was known of the value of these rare minerals at that time, that the possessors considered the finest of their treasures to be worth about a guinea. Cyrus had learned from his brother Elijah, who was then living in the eastern part of the State, the names of some European mineralogists who had made inquiries of him concerning the discovery of Mt. Mica and the disposition of its minerals. With some of these he placed himself in communication, and from time to time disposed of nearly all of the finest of the crystals in exchange for money or minerals. Cyrus afterwards moved to Texas, where he died many years ago; and with him has perished the history and distribution of these gems.

The younger brother and survivor, Hannibal, took but little interest in mineralogy, and gave his share to his brother. He now remembers

only the facts of the discovery, the curious and symmetrical forms, the perfect limpidity, and the wonderful beauty, of the crystals. This is all that is known of the history of the splendid gems and wonderful crystals that Mt. Mica yielded to the explorer in its early and best days. Gathered then in profusion, and carelessly treasured, they have since been scattered over the world, and, in many instances, their identity lost. The late Prof. Cleaveland, a famous mineralogist in his day, received several fine crystals, and among them a superb yellow tourmaline of the purest water. There is now no trace left of these specimens. His cabinet, which Bowdoin College inherited, does not now contain them; but, from the evidence gleaned from his correspondence, it is surmised that they may have been sent to his friend, the celebrated Berzelius, and are now in the mineralogical cabinets of Sweden. Those that fell to the share of young Holmes at the time of the discovery were destroyed many years ago in the fire that burnt the Gardiner Lyceum. In the Imperial Collection of Minerals at Vienna, there are some tourmalines of remarkable beauty; and mineralogists

are at once struck with their perfect resemblance to the Maine tourmalines, especially in their arrangement of color. They came from the cabinet of the antiquary Vander Null, and were simply labelled "America." This is all that is definitely known of them. As the tourmalines of all known localities have peculiarities which distinguish them in a marked degree from each other when viewed by the practised eye, it is easy for the mineralogist to give the locality to the unlettered specimen. Moreover, from the evidence now in our possession, we feel confident that these tourmalines at Vienna are a part of the results of the early exploration of Mt. Mica. Baron Lœderer, an experienced mineralogist, happened to be in Vienna when the Austrian government purchased the collection of Vander Null. He was present at the museum when the boxes were opened; and as he had visited Mt. Mica previously, and was familiar with the peculiarities of the mineral, he at once recognized them to be identical with the tourmalines of Maine. He believed them to have been taken from Mt. Mica previous to the year 1825. The baron is now dead; but

this information was communicated to a geologist in this country prior to 1830. In the Vienna cabinet there is one crystal of tourmaline with both terminations complete. Among those found by the Hamlin boys was a crystal that coincides with this description; and tourmalines of this perfection are of extraordinary rarity.

In 1825, five years after the discovery, Prof. Shepard, a young and enthusiastic mineralogist, visited the locality, and observed a decayed place in the ledge, where a mass of felspar had become decomposed. By digging out this substance, and removing the superincumbent earth, a drusy cavity, or series of cavities, three feet in length and two in depth, were exposed to the gaze of the fortunate explorer. At the bottom of these cavities, among particles of cookeite, lepidolite, and other decomposed minerals, resembling sand, lay a number of magnificent tourmalines of perfect transparency, and exhibiting colors of red, blue, green, and also of variegated hues. Some of these splendid crystals were several inches in length, and more than an inch in diameter; but, unfortu-

nately, they were not in perfect condition. The rain trickling down from the surface of the ledge, through its crevices, had, by the effects of freezing and thawing, cracked and shattered portions of the crystals. The terminations of some of them were broken into fragments; while the shafts remained entire, or slightly fissured. Some of these prisms were green at one extremity, and ruby-red at the other, or green on the exterior, changing imperceptibly to a beautiful crimson in the interior. Others were entirely green or red or blue, or variegated.

The fame of Mt. Mica now became known far and wide; and mineralogists from all parts of the country hastened to visit and explore the locality. The Russian and Austrian consuls, Mr. Cramer and Baron Lœderer, both enthusiastic collectors, examined the deposit, and carried away large quantities of fine specimens.

All the accessible part of the ledge had now been explored; and mining operations of a more solid character were required to follow the continuation of the deposit, which still appeared at the bottom of the excavations. The ill-fated

Prof. Webster blasted down a few feet, and opened a cavity which yielded a grass-green crystal of great purity, quite as long as the finger. At a subsequent time he discovered another cavity, from which he drew out a superb red crystal the size of the thumb. The excited and overjoyed professor sprang to the top of the ledge, and, holding up the beautiful gem in the rays of the sunlight, danced over the rock like a madman, exclaiming that he would not take a large sum of money for it. Nothing more is known concerning these remarkable specimens; but it is surmised that they were sent to Europe, and were probably cut into gems, and may now adorn some of the royal crowns.

From time to time, during a period of more than forty years, many other explorers visited the locality; but they examined it in a superficial manner; and in the year 1865 the deposit was regarded by mineralogists as completely exhausted, although the excavation in the ledge did not exceed fifteen feet square, nor more than six feet in depth. At this time the writer carefully examined the hill, and found no signs of tourmalines, with the exception of a small piece of

lepidolite, which appeared in the pit at the base of its southern wall. With the aid of a miner we placed a blast in the rear of the lepidolite; and, to our joy, the explosion revealed a small cavity about the size of the fist, in which lay a crystal of green tourmaline tipped with red, and an inch in length. Encouraged by this success, we commenced a series of careful explorations, which, undertaken at various times extended over a period of three years.

During this reconnoissance, we removed an extent of ledge averaging about six feet in depth, and amounting in all to more than one hundred tons. Three cavities only were exposed by these explorations; and, as no sign of the mineral deposit remained in sight to cheer the explorer, all further research was then abandoned. All of these three cavities were situated at a depth of six feet from the surface, and contained fragments and *débris* of what were once beautiful crystals of tourmaline. But the water and the action of the frost had, even at this depth, exerted their mighty force upon the mineral, and had rent their solid and transparent forms into numberless fragments. The

crystals lay in their sandy beds undisturbed in regularity of outline; but they crumbled away as soon as touched. Here a summit of a crystal with faceted planes would be preserved, while the rest was destroyed; and there the base or a nodule from the central portion would alone remain among the wreck of the marvel of Nature's work. The base and sides of these cavities were composed of quartz mixed with lepidolite and other firm minerals, forming natural basins, into which the water trickled down from the ledge above through its numberless crevices; and so the tourmalines were constantly exposed to the action of water, until the walls of the cavities became rent, and the water allowed to escape to deeper outlets.

The year following this abandonment of the mine, a party of explorers, searching for mica for commercial purposes, commenced operations at the same place, and proceeded to remove the rock on the eastern side of the pit. They removed about three hundred tons of rock, and descended to the depth of quite eight feet. At nearly this depth, the miners struck five well-

defined cavities on a line ranging from east to west, but disconnected with each other. All these cavities contained tourmalines in broken crystals of various colors; and in one of them was deposited in and on a mass of white quartz one of the most remarkable groups of tourmalines yet discovered in any part of the world. Separated into fragments by the ignorant miners, they were scattered in various cabinets, and some even cut into gems, before the mass of quartz which served as the matrix was discovered. However, their dimensions were preserved; and from the remaining crystals and fragments the group has been reconstructed in miniature. The mass of quartz was about eight inches square, and five in depth. On its summit arose a crystal of tourmaline two inches in diameter, and fully two and a half in height. It was transparent; pink at its base; changing, towards the summit, to a delicate and gorgeous carmine of considerable depth of hue. On the side of the quartz matrix appeared a fine prism fully three inches in length, and three-fourths of an inch in its longest diameter. This crystal was transparent, and

of the purest grass-green; in fact, some of its fragments cut gems resembling very closely the finest of the Peruvian emeralds. Another crystal, of unknown length, but more than an inch in diameter, was of a beautiful blue-green in its centre, surrounded with a coating of clear white tourmaline a line in depth. This was also surrounded by three other layers of transparent tourmaline, each about a line in depth. The first was pink in hue; the next, limpid white; the last, and the exterior, was a soft celandine green. The fragment which has been preserved, when viewed axially, presents plainly this remarkable arrangement of color. There were other crystals of white and green, or white passing to a very light blue. The whole number of distinct crystals arising from the mass of quartz as a matrix were nine; and all were transparent.

The writer, again taking courage at the success of the mica-hunters, commenced explorations on the northern and eastern wall of the pit. Several fine specimens of rose-red lepidolite, and some other lithia minerals, appeared on the side of the excavation to give hope to the

mineralogist. Eighty tons of rock were removed in this operation before a cavity was struck. One ton of lepidolite was obtained, including a large mass weighing five hundred pounds. The cavity proved to be a large one of more than a bushel capacity, and yielded a great number of minute crystals of tourmaline, besides several large specimens, which, unfortunately, were in a state of disintegration. Some months afterwards the exploration was continued, and in the same direction, — to the northeast. After removing forty tons of rock, a small cavity the size of the hand was opened, and yielded a broken crystal of dark green the size of the thumb, and a remarkably slender prism of bluish green more than three inches in length, and one-fourth of an inch in diameter. This singular specimen is a facsimile of some of the Siberian beryls, and will readily pass as such.

In this last exposure of the ledge, no lepidolite, and very few of the associate minerals that accompany the tourmalines, were obtained; and, from the appearance of the wall, the miners concluded that the eastern limit of the

mineral deposit had been reached: therefore the exploration in that direction was stopped.

The next summer the western flank was examined; and, a few preliminary blasts having yielded positive signs, the miners were directed to blast out an extent of the ledge amounting to about sixty tons. During this removal, several decomposed spots in the albite, enclosing tourmalines, were discovered; and finally a large cavity was reached, which yielded many minute crystals of pure white tourmalines, and fragments of what were once magnificent crystals of white and red, and white and dark blue.

A month later in the season, the work of blasting out the western flank was resumed. Fifty tons of rock were removed; but not a single tourmaline, nor a specimen of the rare minerals associated with them, was obtained. We then arrived at the conclusion that both flanks of the deposit had been reached; and the only hope of obtaining further tourmalines lay in blasting out the central portion of the ledge. To reach the imaginary line of the tourmaline deposit will necessitate the removal of large quantities of rock to the depth of eight feet; and, as this

operation will require a large expenditure of labor and money, all further attempts to explore the ledge have been abandoned. We do not, however, consider the locality as totally exhausted; but we regard all future mining operations in search of the tourmalines as extremely hazardous and costly.

From the data afforded by the removal of many hundred tons of rock, and the exposure of a large extent of the mineral-bearing portion of the ledge, we have arrived at the conclusion that there is no well-defined deposit; neither is there any semblance to a vein in which these minerals may be traced with a degree of certainty. But there is an indefinite arrangement, an imaginary line at a fixed depth below the surface, in which we find the tourmaline deposits, and, in fact, all the other rare minerals for which Mt. Mica has become famous. This line dips to the south-east, and descends gently from the place discovered by the students down to the bottom of the south-eastern wall of the pit, where it disappears eight feet below the surface.

To describe this strange deposit in strictly

scientific terms will indeed be a difficult task; but we will endeavor to make it appear in the same light to our readers as it appeared to us. The ledge, in its early days of examination, seemed to be foliated, but not stratified; and consisted of layers of granite, bending with gentle inclination toward the north-west. This inclination of the layers, at first gentle, is now observed, at the back of the pit, to be almost perpendicular. These folds of the granite lay like the leaves of a book, but not of a definite thickness. As they bent over to a certain extent, the coarse granite of the superior rocks suddenly changed in character. It was granite still; but the arrangement of its particles had undergone a decided change. The masses, flakes, and coarse crystals of albite, the large nodules of quartz, the broad plates of mica, and the huge and numerous crystals of schorl, vanished; and, instead of them, a ledge appeared of firmer texture, but composed of much smaller particles of the same materials. The line of demarcation was quite apparent; yet there was no line of decided and distinct separation. Along this imaginary streak of changed ar-

rangement of material occurred the tourmaline deposits. They sometimes happened in the folds of granite a foot or two above this line, but never below it. Of all the twenty cavities known to us, we are not aware of a single one occurring below this change in the rock. The early explorers found the deposits at the surface, and followed them to the southward, about fifteen feet in distance, where the streak had declined to the depth of six feet below the surface. There was no direct communication between these cavities, or pockets; but the soft and partly-decomposed rock indicated deposits beneath or beyond. In fact, the fifteen feet square extent of ledge excavated in the early days was fairly honeycombed with cavities. But the later explorers were obliged to grope in the dark, and trust to hazard in their search for the mineral treasures. Cavities were suddenly found at a considerable distance from the first workings, and often when hope of success was nearly abandoned. The appearance of lepidolite was often a sign of coming success, especially when followed by masses of smoky quartz. When a broad layer of felspar was found to be

changing into regular and broken flakes, a deposit or a cavity might safely be prophesied to occur beneath.

Interspersed throughout the ledge in great abundance appeared well-defined but shattered crystals of black tourmaline, some of them more than a foot in length. In the rear wall of the pit, a huge crystal nearly three feet in length may be seen to-day dislocated and shattered. But, strange to say, among all the cavities in which the transparent tourmalines were found, not a single crystal of the black variety occurred. It is a remarkable fact to be considered in the formation and deposition of this mineral.

The cavities generally were roofed with albite; whilst the sides were composed of limpid or smoky quartz mixed with lepidolite, crystals of tin, spodumene, amblygonite, and other rare minerals. These cavities were of irregular shapes, and of sizes extending from the capacity of a pint to that of two or more bushels. The interior was always filled with a substance resembling sand, but which is probably disintegrated cookeite and gray lepidolite. Lying

loose in the sand, and generally at the bottom of the cavity, appeared the beautiful tourmalines, often unattached, and disconnected with any matrix except the loose sand. Sometimes, however, they were attached to the walls of the cavity, or, broken by unknown cause, became separated from their matrix. Occasionally the quartz rock would form fine crystals of pellucid or smoky quartz, which were often transfixed with slender crystals of tourmalines of various colors.

The walls of the cavities, though composed of the strongest materials, were often found rent and shattered by some unknown disturbing force; perhaps by electricity, but probably by the mighty effects of sudden contraction and expansion caused by the freezing of the water which trickled down through the crevices of the rock above, and exposed to the frosts of winter and the heats of summer. To these agencies do we feel inclined to ascribe the shattered condition of the crystals. Sometimes the shafts of the prisms were broken into two or three pieces; and in other instances they were fractured into numberless minute fragments. When the

superincumbent sand was removed, the broken and disintegrated crystal might be seen in its bed with undisturbed outline; but, at the first touch, the symmetrical form crumbled into particles both coarse and minute. Nature had evidently constructed her forms of crystallization in absolute perfection; and the process of disintegration happened long afterwards, probably from external violence.

From the evidence collected by or known personally to us, we believe that Mt. Mica has yielded over a hundred crystals which would be considered as fine and remarkable specimens. Of the smaller tourmalines, ranging from one inch down to microscopic size, no fair estimate can be made; but they amount to many thousands. We have seen specimens containing more than fifty distinct and transparent crystals embedded in masses of lepidolite, cookeite, and albite. Coarse and opaque, or even translucent, crystals of tourmaline, several inches in diameter, and nearly a foot in length, have been found in the great masses of albite and quartz; but all the fine and transparent prisms have been taken from the cavities,

with very few exceptions. These exceptions refer to a few crystals found in portions of felspar, which were soft and pliable, and of similar character to the distinct cavities.

From the data thus far obtained, it is also evident that this deposit which affords the tourmalines is of but little depth, and limited in its area. This superficial degree of deposit is not confined to the tourmaline alone, but is observed with most of the gems, and with some of the metals. It seems as though the light of heaven was required in the production of the gems, as it is for the marvellous and varied hues of the flowers of vegetation. Thus far, nearly all of our precious stones have been found on or near the surface of the earth; and it appears as though the contact of the air or a ray of sunlight was required to build up their forms and perfect their hues. Down in the thousand mines along the slope of the Rocky Mountains the amethyst vanishes below the depth of twenty or thirty feet, while the same quartz crystallizes in its beautiful and definite but colorless forms in the depths of the deepest mines. The diamond and the sapphire belong

to superficial terrains; and we find that the rule of shallow deposit relates to most of the gems. The topaz of Brazil, the beryl of Siberia, the chrysoprase of Silesia, the turquoise of Thibet, or the opals of Hungary, all occur near the surface of the earth, and are never found below a certain depth.

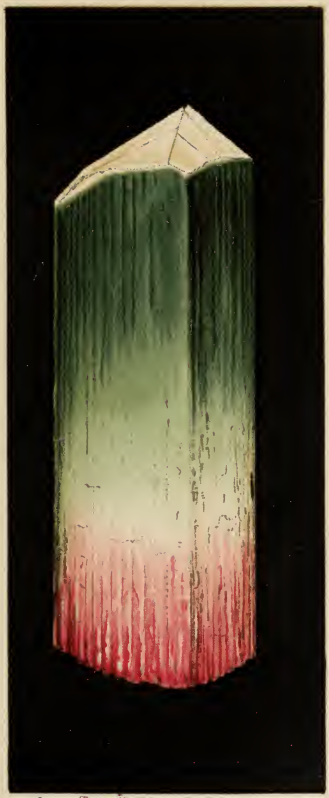
No other deposit in the world yet known to the mineralogist has yielded tourmalines of such a variety of color as Mt. Mica. Some of the fragments of the broken crystals rival in beauty and limpidity, even surpassing in brilliancy, the emeralds of Peru. Others are almost equal to the purest rubellites of Siberia, which resemble the red sapphire; or they imitate with a degree of perfection the dark-green crystals of Brazil, the light-green of St. Gothard, the pink of Elba, the light-yellow of Ceylon, the blue of Sweden, and the rare white of Ariolo.

The arrangement of color often observed in these minerals is very remarkable, and reminds one of the diverse coloring sometimes seen in the sapphire, but on a far more extended scale. In some of the crystals the red changes into

blue, and the blue finally passes into green or black; or the red may pass into white, and the white be tipped with green. In others the color is simply red and green, or white and green, exhibiting many intermediate shades. Generally these transitions and gradations of color are imperceptible as they pass into each other.

But in some specimens the colors are not mingled in the least, and the line of demarcation is well defined and trenchant. So sharply distinct are these crystals in color, that they seem to be composed of several sections veneered together; yet these stones are homogeneous, and cannot be cleaved apart any more than the bands of the onyx.

One very beautiful crystal exhibits a most singular appearance of alterations; and its summit, which is regularly faceted with natural planes, is changed to white to the depth of a line. The contrast of this white cap to the green column of the crystal is so perfectly marked as to suggest the idea that it may be an accidental coating; but examination proves it to be an inseparable part of the crystal.



Chromo by L. Prang & Co. Boston.

CRYSTAL OF TOURMALINE.

Exact Size.

Hamlin Collection.

MT MICA ME

With the tourmalines of this locality we have noticed that the faceted terminations are always green; while the red is never seen except at the termination, which is flat; that is, in well-defined prisms. The crystals may appear entirely red; but they are not terminated nor well defined. This rule is not observed so markedly with the Siberian tourmalines; for with them some of the most beautifully faceted terminations are red. Sometimes the minute crystals may be found penetrating limpid quartz, like the specimens from Ekaterinsburg, which are cut into gems and ornamental stones. They then appear like arrows of rutile enclosed in quartz, but of red and green hues; and from their variety, as well as beautiful appearance, are highly prized by the Russians.

Masses of gray lepidolite and cookeite have been observed filled with crystals of tourmaline, hollow, like thin tubes of glass, with their interior coated completely or partially with yellow cookeite arranged in filaments, in tufts, or in masses. Some crystals have been found composed of a columnar structure, made up, as it were, with bundles of acicular crystals.

Others have been observed strangely compressed in their form; and sometimes, when occurring in the mica, they have been reduced to a line in thickness, even when two inches in length.

Well-marked specimens of dislocated and curved crystals have frequently been found; and some beautifully-radiated tourmalines of a transparent green color have been exposed by rifting masses of mica. Sometimes we observe in the solid masses of quartz or felspar well-defined crystals of tourmalines articulated like pillars of basalt, and whose sections have been separated at some distance by the intervening rock. These singular modifications give rise to curious speculations as to their cause. The separation has evidently taken place while the crystal was forming; for the shaft of the prism is often complete and symmetrical, although its sections may be separated at the distance of several inches. This peculiarity is noticed with all the varieties, but is particularly marked in the black crystals: and so liable are they to this defect in homogeneity, that solid sections, or even masses, are rare; and a complete, unbroken prism has not yet been found.

What was the disturbing force? and at what period of the deposition of the mineral and its matrix did it take effect? These are themes of inquiry which are easy to conjecture, but difficult to determine.

Sometimes the acicular crystals are drawn out to a delicate fineness; and, in several instances, they have been seen arranged in groups, and as minute and silken as the thistle's down. Massive and opaque specimens have been occasionally met with; but they are rare: for the force of crystallization has left its impress upon almost every rock at Mt. Mica, and the rigidity of its laws has been well marked at this locality. Many perforated crystals have also been seen, occurring in thin, glass-like tubes sometimes more than an inch in length, but generally less. The interior of these singular crystals is often free from any substance; but some of them are filled with kaolin or cookeite of gray, white, or yellow shades.

In some of the masses of quartz, mixed with cookeite and lepidolite, remarkable but small cavities may be observed. These cavities are often empty; and their sides are beautifully

striated, as though Nature had prepared a mould, and intended to deposit crystals of tourmalines therein, but had forgotten to do so. Some of these cavities are studded on their sides at random with minute transparent crystals of quartz partly covering the beautifully-defined striæ.

Some prisms have been observed transfixed by other crystals of tourmaline, indicating that opposite forces were at work during the process of crystallization. All the crystals have not perfect terminations; and often we meet them without any well-defined faces. Some of those found embedded in kaolin are of irregular form, and indicate that Nature, restrained by disturbing causes, has left her work imperfect both in symmetry and color. This hiatus in the regularity of the deposit is far more common in the pale pink tourmalines than in any other. Some of these irregular tourmalines are translucent, and composed of columnar-like masses, having the lustre and adamantine refraction peculiar to some varieties of felspar. Many of the crystals are coated in places with a thin deposition of cookeite, generally of a white,

gray, or yellow hue. Some of the smaller prisms have been found completely enveloped with cookeite.

This rare mineral, cookeite, appears to be peculiar to the deposits at Mt. Mica and Hebron; for, amongst all the specimens of tourmaline we have seen from other parts of the world, not one exhibits the least trace of it. It belongs to the lithia group of minerals; and if it is really a product of alteration of the tourmaline, as some mineralogists suppose it to be, it is remarkable that it has not been found in some of the other tourmaline localities in Siberia or Brazil. Some large masses of cookeite mingled with gray lepidolite have been literally filled with transparent crystals of tourmalines of various colors, and of a great variety of shapes and conditions. Not only single prisms, but also multiple crystals and radiated forms, might be observed in these masses. Their deposition in the matrix, without any regular arrangement, recalls to mind the singular beryls of the Adun Tschilon in Siberia, and which lay at all angles in the mass of hydrous oxide of iron. Some of these remarka-

ble cabinet specimens have been found containing fifty or more defined crystals of tourmaline.

Transparent tourmalines of similar forms and colors have also been discovered in the side of an abrupt hill in the town of Hebron, about seven miles south-east of Mt. Mica. This locality was also discovered by accident. An itinerant lecturer who possessed a love for the beautiful and rare in Nature, and who had passed hours at Mt. Mica studying the geological formation of the place, was travelling through the town of Hebron, on his way to the neighboring village, not many years ago. As he rode along the valley, he espied a bowlder of rose-red lepidolite in the stone wall by the roadside. He recollected that this rock was one of the associate minerals of the tourmaline; and this discovery tempted him to seek for the parent ledge whence the mass had become detached. Climbing over the wall, he observed other fragments in the adjoining field; and, by tracing in this manner the surface of the ground, he soon came to the hillside, where the evidences were far more numerous, and where the deposit undoubtedly occurs. The

ledge, however, is yet covered several feet deep with alluvial soil; and only the detached bowlders have been explored. These have yielded beautiful crystals of transparent and varied hues, and also the same association of minerals we observe at Mt. Mica. The surrounding earth has not been sifted, nor the ledge exposed: therefore it is not known whether the system of cavities prevails here as at Mt. Mica; but there is reason to presume it does, and that some bold explorer may one day reap a rich harvest for his labor.

Some curious specimens of altered rubellites have been found at this place. They seem to have changed into lepidolite, and still retain some of the characteristics of a natural crystal. As naturalists observe hybrids among animals, so mineralogists observe hybrids among minerals, resulting from mixture of isomorphous matters in all proportions. Sometimes one ingredient preponderates sufficiently to locate the mineral with the species to which it belongs; at other times they are all so evenly balanced, that it is difficult to determine the character of the compound: and so these rubellites may be

found of all degrees of alteration, until their forms are lost, and the mineral is decidedly lepidolite.

It is a curious fact, that, by the agency of certain mysterious forces, pseudo-morphs are formed; that is, crystals undergo a change of composition without their forms being in the least degree affected. Even cavities are sometimes emptied of their contents, and minerals of a totally different character deposited therein. The locality at Hebron is now known as Mt. Rubellite, deriving its name from the abundance of red tourmaline.

Five years ago, the same strolling preacher called at the house of a physician in the town of Minot; and, observing on the mantle a specimen of rock containing a green tourmaline, he inquired whence it came. The doctor pointed to a naked ledge of rock on the brow of a hill in Auburn, nearly two miles distant, and informed the inquirer that it was the locality. Not at all daunted by the distance, our venerable enthusiast started for the hill, and soon made known to the world a new locality of transparent tourmalines. The name of the discoverer of these two localities is Luther Hills.

Early informed of the discovery, we called to the place our miners from Mt. Mica, and proceeded to explore the deposit. We found that the tourmalines appeared on the brow of a ledge which projected a little distance from a gentle slope of a hill, and far below its summit. The surface of the rock and adjoining earth was strewn with numerous foliæ of mica containing crystals of transparent tourmalines, and large masses of pink lepidolite, amounting in all to quite a ton in weight. The abundance of lepidolite and mica gave hope of an extensive deposit of the coveted crystals; and almost the first specimen picked up from the soil, exhibiting rich emerald-green hues, gave promise of superior gems. But we found, to our regret, that the deposit was very superficial, and was, in fact, a mere coating to the ledge. A few blasts of the miners soon exposed the entire deposition of the tourmalines and their associate minerals.

The tourmalines found here were of the true emerald-green; and the specimen first found yielded a fine perfect gem of two karats, resembling perfectly the emeralds of

Peru, but of a pale tint. Nearly all of the crystals were acicular, or in acicular groups; and some of them were beautifully radiated on plates of mica. Quite all of the specimens obtained were of emerald-green colors of various intensities of shade: very few exhibited faint pink or rose-red hues.

It is a little remarkable that all of these localities should occur on a direct line from each other, and invariably exposed to the west. The Auburn deposit occurs twelve miles south-east from Mt. Rubellite.

CHAPTER IV.

THE PHYSICAL WONDERS OF THE TOURMALINE. — ITS ELECTRICAL PROPERTIES. — ITS OPTICAL PHENOMENA. — ITS PLAY OF COLOR, ETC., COMPARED WITH OTHER GEMS.

THE tourmaline is exceedingly interesting to the student, on account of its complex mineralogical characters and curious physical properties; in which respect it far surpasses all the other gems. Its crystals are almost always differently terminated; which is an exception to the law of crystallography, that all facets of the same kind should similarly be reproduced on all identically similar elements of a crystal. It was thought, for a time, that this crystallographical anomaly exerted some relation over the electric properties of the stone; for, when one of its prisms was heated in a particular way, two kinds of electricity were mani-

fested, — one end exhibiting positive electricity, and the other end becoming negative; and this had been observed so often as to be regarded as a uniform fact. But some of the rare tourmalines from Pegu and Ceylon, which possess terminations regular and exactly alike, likewise exhibit the same phenomena of the double property.

However, it generally manifests positive electricity at the termination which has the greatest number of facets; and this latent force may be easily aroused by friction or by the application of heat. This state of polarity may be reversed by intense cold; and that which is positive suddenly becomes negative, and *vice versâ*. If one of the prisms be broken while in an electric state, excited by heat, the fragments instantly present opposite poles, like artificial magnets. It is also shown, that, if it be heated somewhat above 212° Fahrenheit, it loses its electricity: but, if the increasing heat is continued to a certain degree, it again becomes excited; but its electrical poles are now reversed.

The proper degree of heat required for the

exhibition of the electrical power of the tourmaline is from 100° Fahrenheit to 200°. Haüy discovered, that, by heating a crystal unequally in the focus of a lens or mirror, the position of the poles might be changed. To M. Æpinus, the German physician, and to Mr. Canton, the English electrician, is due most of the honor of making known the electrical properties; and especially to Mr. Canton, whose researches were published in the Proceedings of the Royal Society in 1759. Dr. Priestley, seven years later, turned his able attention to the peculiarities of the stone, and discovered a method of reversing all the experiments made upon it; making that side which is positive in heating or cooling to be negative, and that which is negative to be positive; so that the kind of electricity shall be just what the operator shall direct by the application of proper substances to the stone. These curious experiments will be found explained at length in the Philosophical Transactions, Franklin's Letters, and Priestley's Works.

The phenomena of electricity exhibited by the gems are very interesting; and the nature of the subtle agent is quite as mysterious to-

day as when the Milesian school of Thales, more than two thousand years ago, discovered the unknown force by the friction of a bit of amber. We find that some of them become electric with the greatest ease, like Iceland spar or the topaz; and sometimes they become excited by merely pressing them between the fingers. Others acquire the property with the greatest difficulty. Some retain the power for several days; while others, like the diamond and quartz, lose it almost instantly.

The transparent and perfect stones seem to possess more of this mysterious property than the translucent or opaque. The native garnet will not become electric by friction until its sides have been faceted by the lapidary. Generally all polished and transparent stones acquire positive electricity; but the effect is the reverse when they are rough like unpolished glass. The diamond is the exception to the rule, which relates to all combustibles which acquire negative electricity by friction. This property of acquiring electricity, and the comparative degree of strength, form important characters for determining the

nature of gems, even after they have been polished, and set as jewels.

Some of the tourmalines exhibit the strange play of color which is called dichroism, and which is especially seen in perfection in the transparent mineral known as iolite. The term "dichroism" or "polychroism" is applied to a mineral when it displays two or more colors when viewed in different directions. The cause of this remarkable change of hue is still obscure, but is supposed to be due to a certain mixture of polarized with ordinary light, and is therefore only seen in minerals which possess double refraction. But few of the gems possess this singular property, even in a slight degree. The sapphire sometimes, but rarely, exhibits the play, but never in a decided manner, like the iolite. The rare and transparent andalusite from Brazil displays the property in a charming manner, and may exhibit in the same specimen delicate shades of white, green, and pink, according to the position in which the stone is viewed.

It is in the tourmaline, however, we witness the display of polychroism in its greatest

perfection. Some of its crystals, when viewed parallel to their axes, appear of a splendid crimson hue; but, when the prism is slightly turned, the red color vanishes as if by magic, and the stone becomes white or smoky or green, without the least tinge of its former hue. Other crystals are green when viewed transversely, and yellowish brown axially; or they may be dark violet transversely, and greenish blue axially.

The range of diversity of color displayed by this mineral, when viewed in this manner, is very great; but all its crystals or masses do not possess the property with equal intensity. Some exhibit it with great distinctness; while other specimens display only a trace of it, and some none whatever. Turn the fragment whatever way you will, the color remains the same, and unchanged. This absence of dichroism is best observed in the light-colored specimens, which possess double refraction in a feeble degree.

The ancient glass-workers, and especially those of the third or fourth centuries, discovered the means of producing this strange

optical effect at will; and there are still remaining some splendid examples of their skill. The two cups sent by Hadrian to his brother-in-law Servianus are very curious; for, although of a bright-green tint when seen by reflected light, they turn to a ruby-red when light is transmitted through them. The ancient glass relic in the collection of Baron Lionel Rothschild is of a pale ruby color by transmitted light, and of a pale opaque green by reflected light.

This phenomenon often appears under the influence of artificial light; and the laboratory of the chemist affords numerous and pleasing examples. Several of the compounds of chromium are green when seen by daylight, but change to a purplish red when viewed by candle-light. One of the most remarkable examples is shown by viewing a tree in full foliage, and holding between the eye and the object a flask containing a green solution of chromium. Although the tree and the solution may be of the same color, yet, when it is looked at through the solution, the foliage changes to a bright purplish red color.

The causes which give rise to the great variety of colors among the tourmalines, as well as the other gems, form interesting themes of inquiry; and they are yet subjects of controversy among scientific men, and probably always will be. The study of the origin and play of color — whether we take the gems, or the more perishable flowers and fruits of vegetation, or, in fact, any of the objects of natural history — is one of the most delightful yet perplexing inquiries in the secrets of Nature. The variegated hues of the flowers puzzle the philosopher; but they and the prismatic flashes of the diamond are no less interesting and inexplicable than the illumination of that marvel of the insect world, the fire-fly of Jamaica (*Pyrophorus noctilucus*), which displays at the same moment magnificent flashes of green and red light.

The chemist says the rainbow-hues flashing from the transparent gems, and dazzling the eye with their lovely and fugitive play, are only the effect produced by the presence of certain oxides of the metal. "Color," exclaims the philosopher, "is only the absorption

and reflection of light, or simply the difference in the rate of vibration of the rays; and that color is not always inherent, but is developed by some extraneous cause." One chemist declares the amethyst to be colored by the oxide of manganese; but another, more particular in his analysis, finds none: yet the glass-workers produce facsimiles by means of that metal. Still another maintains that color is due to the complex structure of certain chemical molecules, and points for instances to the splendid aniline colors, whose royal hues appear one after the other according to the combination of these molecules.

Certain gems change their hues when heated, but return to them when cool, like the spinel and the Saxon topaz. Can the color, then, be considered ponderable? or is it only the molecular arrangement of its crystallization which produces the colored rays? Prof. Stewart asserts that the powers of radiating and absorbing light depend greatly upon molecular condition, and shows that a tourmaline heated to incandescence emits light polarized in a plane perpendicular to that which it trans-

mits. Here the structure that enables the crystal to take up wave-motion in one direction only, compels it to impart motion exclusively in the same direction. Hoffman's celebrated experiments seem to indicate that each particular degree of refraction causes a different set of vibrations, resulting in a different sensation for every part of the spectrum, and reproducing the effect of various colors on the optic nerve. The action of the galvanic battery on the aniline series suggests the idea that the colors evolved are due to nascent oxygen, and that the tint corresponds to the degree of oxidation.

We say that solar light is quite if not absolutely necessary for the production of color, and that the shells of the mollusca, living at great depths in the ocean, where total darkness is supposed to reign, are devoid of any decided hue. Yet there are remarkable examples to the contrary; for most of the zoophytes living at the same depths as the mollusca are nevertheless high-colored animals. The ulocyathus is of a refulgent scarlet, yet lives at the depth of more than

one thousand feet; the actinopsis is of a fine yellow; and the capnea displays a decided red tint: yet they flourish and propagate at the enormous depth of nearly two thousand feet below the surface of the ocean. These phenomena may depend upon the food of the animals; and it may come floating down from the upper waters, and produce similar effects to those we witness among animals on land when fed with peculiar food. The beautiful red coral, however, is never found colored below the depth of one hundred and fifty feet; and the finest tinted specimens come from the depth of twenty-one to twenty-four feet.

It was once affirmed that the immense range of color we observe in the almost endless variety of the flowers of vegetation is due to different proportions of the oxides of the metals; and that especially the changing and gorgeous hues of our autumnal foliage were produced by the effects of that chameleon of minerals, manganese. But we now think that it is from the rays of the sun and their effects we derive all the beautiful colors that deck animate and perhaps inanimate nature. They certainly give to

the earth the tender blue of the violet, or the delicate crimson of the rose; the gorgeousness of the plumage of the peacock, or the brilliant decorations of the insect world; the lovely green of the meadow, or the purple and golden shadows of the distant mountains. And in those countries where the sunlight is the most constant and powerful, there we find the colorings of animal and vegetable life in the greatest variety and perfection. We may even carry our speculations still farther, and maintain, with a degree of probability, that many of the minerals derive their colors from the same source.

In seeking for the causes which give rise to the multitude of hues observed in the gems, many interesting and mysterious results are obtained in the experiments of the laboratory. These experiments are varied, and almost endless; but at the present time we will content ourselves with reviewing some of the effects produced by heat.

Protoxide of iron, says the chemist, colors the tourmaline, as well as the spinel, chrysoberyl, sapphire, emerald, zircon, garnet, turquoise, chrysolite, and others among the gems. Yet these

stones, when exposed to the fire-test, or red-heat, exhibit phenomena which hardly support the general views of the chemist. The vivid as well as the more delicate hues of the red tourmaline vanish like magic almost at the first touch of the blow-pipe flame; while the green and the blue are not much affected at a higher temperature. The charming tints of the emerald are completely destroyed by a red-heat; while the green sapphire and the green diamond are unchanged. The garnet loses its red hues by heat; but the green are preserved. The Saxon yellow topaz changes to white when exposed to a high degree of heat; but the Brazilian topazes, of darker hues, become of a beautiful rose-pink at a low temperature: but, if the heat is continued to a certain degree, neither hue can be recalled, and the stone becomes colorless. The red sapphires often gain a deeper tint; while the bluish in color sometimes become snow-white. Most of the sapphires retain their hues even after having been submitted to a very high degree of temperature. Berzelius found that the red spinel of Ceylon, when exposed to the action of fire, became brown; then black and opaque; but,

when cooling, it changed to green; then afterwards became limpid; and finally was restored to its original color. The diamond, when heated, sometimes becomes pink; which color gradually fades away on cooling. The hues of the amethyst and zircon are completely destroyed at a red-heat. The chlorophane from Siberia exhibits an emerald-green when heated: and still another variety from the same locality, when heated to 212° Fahrenheit, phosphoresces, and becomes green; but, when heated to a still higher temperature, it becomes blue. In all cases with the fluor-spar, when the phosphorescence ceases, the color of the mineral disappears, and never returns. In the outer and inner flames of the blow-pipe may be seen remarkable effects, which are not clearly explained by the oxidizing and deoxidizing power. Protoxide of iron with the fluxes gives brownish-yellow in the outer light, and a light green in the inner. Oxide of copper with borax gives a green light in the outer flame, and a red in the inner. The oxide of nickel with borax gives a red bead of glass in the outer flame, which becomes white when cool. Binoxide of vanadium likewise

gives a yellow bead in the outer flame, which turns to green when cool. The globule of glass formed with borax and titanium is often emerald-green; but, with a greater quantity of borax added to it, the bead becomes red, which passes to blue or white, according to the degree of heat to which it is exposed.

These experiments, which may be continued with varying effect *ad infinitum*, seem to indicate that crystallization or molecular arrangement has something to do with the definition of color; for heat has the property of removing the integral particles which constitute a body to a greater distance from each other. This idea of molecular arrangement giving rise to some of the colored rays is strongly supported by the revelation of the microscope, which exhibits infinitesimal crystals within the transparent gem. A beautiful illustration of the theory is witnessed in the star sapphires, which, when held directly against the light, exhibit white or yellow stars of long slender rays, sometimes in the midst of a deep blue or red ground; but, when held up to the view in any other direction, the star is invisible. This phe-

nomenon is probably due to myriads of minute crystals, which are arranged in a number of definite planes so as to give rise to the stellate appearance. Mr. Lea, in his extensive microscopic researches with the gems, finds many of them composed of multitudes of crystals which are acicular, cuneiform, or plate-like, or triangular in form, with an angle very acute. Some of the gems appear to be composed of bundles and groups of these minute forms; while in others they are widely separated, or apparently absent, or so small as to escape observation. The garnet affords many beautiful illustrations of crystals within crystals; but, as yet, this veteran observer, after a great number of examinations, has not been able to detect any microscopic crystals within the tourmaline.

Artificial light acts strangely with some of the varieties of the tourmaline, and also with many other gems. The beautiful crimson flashes of some of the red tourmalines vanish as if by magic when viewed by candle-light; and the stones become brown, lustreless, and seemingly opaque. The green varieties are heightened in hue, and the blue are unchanged. The dia-

mond flashes out its dazzling prismatic rays best by artificial light. It gains vastly in intensity and brilliancy; while the emerald loses perceptibly a part of its superb tint and exquisite lustre. The chrysoberyl from Siberia, called alexandrite, is of a dull green by daylight; but by night this color vanishes, and gives place to a reddish amethyst hue. Imagine the surprise and the chagrin of the amateur, who, obtaining an alexandrite for the first time, hastened to exhibit to an old crony the green gem from the Ural Mountains. The candle was lighted, the table arranged; but, when the green stone from Siberia was rolled forth upon the cloth, it had changed into red!

Some sapphires, which are of a lovely blue tint by day, become of a beautiful amethystine tint by night: other sapphires lose their blue color completely by night, and appear black. The greenish turquoise changes to a celestial blue by night.

The explanation of these strange and beautiful transformations has been partially revealed by the spectroscope; and it is now shown that the cause is sometimes due to the difference in the

illuminating lights, as is shown in their spectra. The artificial lights produced by gas, oil, or candles, exhibit in their spectra the same range of color which is seen in the solar spectrum; but each color has not the same relative force. As the artificial light from gas and candles has much less blue than solar light, it is evident that the latent red hues of the gem will preponderate over the blue; and hence some of the stones which are blue by daylight will exhibit amethystine hues by artificial light at night.

A beautiful example of this theory is seen in some of the blue sapphires, which display a superb violet tinge by candle-light.

We may, perhaps, explain by the same theory, or by the absence of certain wave-lengths in the illuminating light, the remarkable changes that take place in some of the purple varieties of tourmaline; or we may account for them by that strange property called "fluorescence," which possesses the power of changing the light in which the object is made visible.

The French jeweller Barbot, in speaking of the tourmaline, well says, "that it seems as if Nature had wished to prove to man that she

could imitate in a degree almost perfect even that which she had created the most perfect." And, so far as color is concerned, she has succeeded admirably; for she has endowed the tourmaline with most of the colors observed among the gems. From the wondrous hue of the emerald, which may be taken as the type of all the greens, the color of the tourmaline passes down in easy gradations to the dull shade of the plasma; from the fiery and gorgeous red of the Pegu ruby to the opacity of the jasper and porphyry; from the cerulean blue of the Ceylon sapphire down to the intense black of the carbonado. No other gem has such a vast range of color, not even excepting the sapphire or precious corundum; since the suite of corundum greens is very limited, whilst that of the tourmalines embraces all known shades.

It is often stated that the tourmaline has but little commercial value, and is valuable only for scientific purposes; but, among experts, it is regarded as equal in price to the ruby, the emerald, the sapphire, and the topaz, when it resembles those gems. There

can be no reasonable objection to this valuation; since the stone is equal to the emerald in hardness, and even superior to it and the topaz in its brilliancy. This view is also entertained by the eminent Prof. Beudant of France.

The tourmaline, as we have said before, is a compound silicate of alumina mingled with a great variety of other elements, but in slight proportion; and it is from the two elements, silica and alumina, we derive most of our gems. The emerald, garnet, quartz, onyx, sardonyx, idocrase, andalusia, topaz, are all silicates. The sapphire, with its red, yellow, blue, and varied tints, is pure alumina. The opal, with its thousand charming prismatic hues, is only hydrated silica.

This mineral, silica, seems Protean in its forms and combinations. It not only appears in the crystallizations of the earliest periods of the earth's history; but we find it in the petrifactions of recent times, as in the teeth of the rhinoceros, and other extinct animals of the "Mauvaise Terres" of Nebraska, or in the clam-shells of the Arkansas. We also find it in the animal kingdom; and the shells of many infu-

soria are composed of it. We even drink it in the waters of our bubbling springs, and respire it in the floating dust of the air. It is also silently and mysteriously deposited every day in vegetable life; and the same element that adorns human beauty in the emerald, the tourmaline, and many other gems, gives the gloss and the enamel to the bamboo, and strength to the wheat-stalk, to support its ripening grains.

The optical characters of the tourmaline are indeed wonderful, and they belong almost exclusively to this one mineral. Some of its crystals, when viewed perpendicularly to the sides of the prism, appear of a clear and lively color, and perfectly transparent; but, when they are observed in the direction of their axes, the same limpid stones become opaque. Not a ray of light can be made to struggle through them; in some specimens, even when the length of the prism is less than its thickness. There are, however, wide variations to this degree of opacity; and some of the crystals which possess double refraction undergo no change in transparency, no matter in what direction they may be viewed, being perfectly limpid.

In many of the gems, the ray of light falling upon them is refracted, and divided into two distinct rays. This singular property is called double refraction; and it enables us to distinguish many mineral substances, for all do not possess it. We can thus easily detect crystal from glass, the ruby from spinel, and the zircon from garnet, and many others. The tourmaline exhibits this property; but, when cut in thin plates parallel to its axes, it also possesses the strange and extraordinary power of extinguishing, or causing to disappear, one of these rays of light, while the other is preserved.

This peculiarity of absorbing one of the polarized rays of light is taken advantage of by the experimentalist; and it furnishes a useful and valuable aid in the study of optics. The Mt. Mica stones do not polarize light so well as those from Brazil, or the brown varieties from Carinthia. In fact, the light colored from Maine act very feebly when submitted to the test; and it is doubtful if the clear white do at all. The best polariscopes are made from a slice of a dark-green Brazilian tourmaline

opposed to another cut from the brown of the Tyrol. Not a ray of light passes through this instrument, unless a body possessing double refraction be interposed between the two plates of tourmaline. If the transparent mineral is rough, and has not been properly polished for examination, recourse may be had to the use of a glass cell containing a fluid of a high refractive power, like the oil of cassia. The stone immersed in this fluid admits the light in all directions, and is then easily viewed through the plates of the instrument.

By means of this polariscope, which is often called the "tourmaline tongs," the expert is able to detect instantly the character of many of the gems, even when polished, and without the labor of estimating other characteristics, as specific gravity, electrical properties, &c. The ruby is thus distinguished from spinel, the zircon from garnet and many other stones, by their difference in refraction. But there are exceptions to the use of this instrument in the estimation of gems; and the experimentalist must be on his guard, lest he pro-

nounce substances to be of double when they really possess but simple refraction. Glass has a tendency to crystalline regularity when heated and cooled suddenly; and consequently acquires the property of polarizing the ray that passes the first plate of tourmaline, and disposes of a part of that which passes in the second. Certain minerals of the cubic system, like the diamond, which generally exhibits single refraction, produce the same result also by reason of a certain forced arrangement; and, on the other hand, some crystals, like the topaz, when cut in certain directions to their optical axes, cease to exhibit the phenomena of double refraction.

It is interesting to examine this wonderful mineral deposit at Mt. Mica, where the tourmaline occurs in such perfect beauty, and to conjecture how Nature constructed these marvellous stones in the very heart of the granite rocks; how she silently built up in the darkness of the miniature caverns, or in the very substance of the granite itself, the transparent atoms of their crystal forms; how she touched them with the fiery red, the lively green, the mellow yellow, the sombre black, or the tender blue;

how, at times, she separated these hues in the same crystal as if by magic touch, or blended them together in exquisite transition and gradation. Here, among this grand display of the rare and the beautiful, Steno might have properly spoken of the play of Nature, — Steno, who began geology; whom Deluc called the first geologist.

We may imagine Nature at work creating these gems by the same law by which she constructs the crystals of snow, whose forms are almost endless, but whose every angle is one of sixty degrees. How she does this we may perhaps learn by destroying a block of ice by means of the electric beam, which delicately dissects with infinitesimal touch the structure of the crystal edifice by reversing the order of its architecture. "Silently and symmetrically the crystallizing force had built the atoms up: silently and symmetrically does the electric beam take them down. Here we have a star, and there a star; and, as the action continues, the ice appears to resolve itself into stars."

This process of crystallization is indeed replete with wonders. It is a marvellous play

of forces, that enables the molecules of bodies to build up those beautiful crystals whose sides and faces are as polished and symmetrical as though shaped by the dexterous hand of the lapidary. Some rocks exhibit certain forms of crystallization with unvarying restriction ; while others are more flexible in modes of construction. Yet there seems to be nothing left to chance. Everywhere fixed laws affect the conformation, and determine the structure, of the whole. The diamond erects itself into a crystal from atoms of carbon; the sapphire is shaped into symmetrical form from atoms of alumina; and the tourmaline is built up of a multitude of substances, all combining in definite proportion.

Although the forms assumed by the different minerals and salts occurring in Nature appear, at first sight, infinitely variable, and independent of all fixed principles, yet the ultimate forms have been reduced to a few. In studying the composition of these gems, we may learn of the remarkable laws which govern all combinations, and startle the inquiring mind with new ideas of the infinite. In many of

these complex minerals, man has not yet discovered the law of combination. Yet, with wonderful patience and skill, he has unravelled some of the simpler problems; and he has so far obtained an insight into the workings of Nature, that he knows that certain bodies, simple or compound, combine between them in a determinate and fixed proportion, and admit of no intermediate.

CHAPTER V.

ORIGIN OF THE PRECIOUS STONES, ETC.

WHEN and how were the gems deposited? and has Nature ceased to reproduce them? is often asked by the inquiring mind. This is a question not so easily answered as it may seem at first sight; and there are many facts known to the mineralogist which incline the observer to believe that Nature (or rather her forces in this respect) is not yet exhausted. There is a widespread belief among the numerous and far-separated diamond-seekers among the gem mines of India, that the diamond is being constantly reproduced; and this idea, though apparently absurd at first glance, is not destitute of plausibility when we come to consider the geological conditions of the gem districts, and the phenomena of terrestrial magnetism which are observed there. The artificial

production of a great variety of minerals among the slags of furnaces affords corroborative evidence; and we may see to-day the opal and hyalite forming from the decomposed cement of the Roman ruins in the hot-springs of Polombières. Nature, evidently, still possesses the power. Certain conditions alone are wanting.

The mysteries of this creative power have not yet been solved by science; but investigations thus far go to show that the ancient astronomers — Hermes, Ptolemy, and others — were quite right when they maintained that all things here below were governed by the influence of things above. It is perhaps true, that the grand geological changes of the earth have ceased; but, nevertheless, the mighty and mysterious forces that deposited the metals, the gems, and arranged the formation of the conglomerate rocks, or those of a high molecular organization, are yet at play. Every glancing sunbeam contains a world of power within itself; and its effects are visible and felt on every side. In the tiny columns of dust whirling in the road, the tall sand-pillars sweeping majestically over the desert, the water-spouts of the ocean, the terrible

cyclones of the tropics, and in the devastating earthquakes, — "those thunder-storms in the earth," — we witness phenomena due to the same Protean and wondrous force, — electric action. "The brilliant folds of the aurora — that magic arch, surpassingly beautiful by the brilliancy of its colors, mysterious from its swift and silent play across the heavens, flaming as with the glow of unseen and unearthly fires" — are also due to the same influence, or terrestrial magnetism.

All these wonderful changes and results are not produced by the earth itself, but are due to extra terrestrial influences, — the cosmical action of the surrounding bodies in space, the varying action of the sun, moon, and stars. From the sun proceed these strange impulses; and, in fact, the whole electric system of our globe quivers, as it were, continuously under the influence of the solar forces. All motion on the earth, all life, even death itself, comes to us in the sunbeams. We must not, however, confound electric force with the creative power. Electricity is not life: it is only the instrument of life, and nothing more. This subtle agent is

ever present on earth, and never ceasing in its action. Not only do we witness its marvellous play in inanimate nature; but we may find it constantly at work in our own bodies. It performs a part in the perfection of human thought and physical beauty, as well as in the vitality of the vegetable world or the delicate forms of crystallization. We little know of the vast energies of this unseen power, which are silently and constantly exerted around us in every chemical change.

Where the skies are the fairest, and the sunshine the most constant, there the electric disturbances are the most powerful, and there we find the magnificent colorings of animal and vegetable life in the greatest perfection and variety. Even the clouds that clamber up the sides of the lofty peaks of the Andes are observed to assume richer hues and shades when they approach the trachyte ledges. For a long time, when most of the gems brought to the commercial markets came from Southern Asia or the equatorial regions of America, it was thought that the heat and light of the tropics were required for their pro-

duction; but we now find them, though in limited quantities, among the snows of Siberia, and beside the glaciers of the Alps. However, it is a singular fact, that many of these gems in a remarkable degree lack the tints and lustre of those found under the sun of the tropics. There is, especially, a great difference observed in the spinels of Siberia and North America, and those of Ceylon; the former being dark and impure in color, while the latter possess all the most brilliant characteristics of the species. Naturalists observe the same marked differences in color between the fishes, the birds, insects, and animals of the cold and warm zones. These phenomena are thought to be due to solar influences; and, upon like hypotheses, the magnetic currents ceaselessly playing through the crust of the earth, may, perhaps, to-day produce the diamond in certain favored localities, thus realizing the belief of the Hindostanee when he discovers new gems in the oft-washed sands. In these favored localities, certain elliptics, where the electric forces are in active play, may be readily traced in marked distinction to other territories;

and it is impossible, in the observance of their varied effects, not to connect with them the production of the gems in past times, if not at the present day. How Nature accomplishes these results is yet involved in mystery; but we may glean new ideas from the artificial crystallizations that take place in our laboratories under the action of electricity. Furthermore, may not this Protean agent exalt the properties of atmospheric oxygen, and act like a germ in its transformation of hydrogen into an agent of decomposition and combination? In studying the mysteries of metals, Graham was tempted to believe, from the action of hydrogen in its occlusion by certain metals, that the gas is itself a metal, possessing affinities for other metals; and so firmly was this view fixed in the chemist's belief, that he gave to hydrogen the name *hydrogenium*, considered as a metal. The formation of fulgurites, which shows that the lightning may melt and fuse without evolution of heat, is also to be considered in connection with the study of this subject.

Chromo by L. Prang & Co. Boston.

Section of

CRYSTAL OF TOURMALINE.

Showing arrangement of colors.

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